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UNCERTAINTY IN THE RICE SUPPLY CHAIN DURING PRE AND POST PANDEMIC - A CROSS CASE OF AGRICULTURAL COOPERATIVES IN INDONESIA

Rosyadi[1] and Adi Wijaya[2*]
[1] Faculty of Economics and Business, Universitas Tanjungpura, Pontianak, Indonesia
[2] Faculty of Economics and Business, Universitas Mulawarman, Samarinda, Indonesia

*Correspondence Email: adi.wijaya@feb.unmul.ac.id

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ABSTRACT

Even though the social order is starting to recover from the risk of Covid-19 transmission, but the performance of food security is still constrained in some countries, including Indonesia, where the majority of the population consumes rice. If the infection rate spikes again, it can hamper the supply chain for food commodities such as rice. From this paper, the research target focuses on the structure of the supply chain in rice under government supervision operated by a national company. In distribution capacity, domestic rice is a local type of superior quality to every interisland agricultural cooperative in Indonesia. Overall, this scientific paper calculates the multidimensional disruption in the rice supply chain from across the major islands in Indonesia During a normal situation and after a pandemic. A series of annual report data sourced from the Central Bureau of Statistics (BPS) are tabulated using parametric regression. The research sample is framed in a combination of agricultural cooperatives in 6 objects in Indonesia based on 12 key variables. The time panel is divided into two compositions: 2017–2019 (pre–Covid) and 2020–2022 (post–Covid). The output of the study clarifies that there is a significant relationship between pre–Covid and post–Covid to the manufacturing industry, quality control, logistics, land infrastructure, and sales significantly. Then, there was a significant link between pre–Covid and post–Covid from paddy production to the manufacturing industry mediated by supply, logistics to agricultural cooperatives mediated by land and marine infrastructure, then agricultural cooperatives to consumers mediated by sales. In relation to this research, the participation of stakeholders is suggested to adopt schemes and controls that are integrated with the transition of the rice supply chain.

Keywords: *agricultural cooperatives, covid, Indonesia, parametric regression, rice, supply chain*

BACKGROUND

SARS-CoV-2 or what is called "Covid-19" is still an issue of widespread discussion, especially among scholars. Besides the many losing their lives, this deadly pandemic has also trapped human routines as a consequence of distance restrictions, causing a national and global economic recession (Ratnasari et al., 2022). The external shock caused by the virus has also affected the agricultural sector, particularly disruption to agricultural production in many countries that rely on exports of agricultural commodities (Ahmed, et al., 2021; Okolie & Ogundeji, 2022; Tansuchat et al., 2022). A slowdown in agricultural production has the potential to break the food chain (Abid & Jie, 2021; Aday & Aday, 2020; Pu & Zhong, 2020; Workie et al., 2020). Sridhar et al. (2022) believes the other pressures are felt by the retail and consumption aspects of society. In other words, the phases in the supply chain in agriculture can trigger fluctuations in market balance (Darma et al., 2022)

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Staple food reserves, especially rice which is processed from unhulled rice, makes a vital contribution to national food supply. Information on food stocks plays a concrete role in determining the condition of food security at the household, regional and domestic scale. Access to government rice stocks is relatively easy to get from the competent authorities. The organizers are sub-government, namely the Logistics Depot (DOLOG) and the Logistics Affairs Agency (BULOG). On the other hand, news about stocks and rice is not routinely available to the population. Universally, control of rice stocks is divided into 6 levels: rice milling, processing industry, intermediary traders, food and hotel traders, producer farmers, and household consumers (Tao et al., 2022).

Even though agricultural development plans, including supply chains, have been contained in short-medium-long-term documents, the rapid spread of Covid-19 has changed reality. Disruptions to food supply and production (Barman et al., 2021), increasingly unorganized distribution (Moosavi et al., 2022), transportation flows (Deconinck et al., 2020), and consumption processes (Nekmahmud, 2022). Similar is the case with decreased financial flows in agriculture, stagnant welfare levels, sales volatility, and fears of hunger due to poor nutrition. In fact, Indonesian government regulations have allocated subsidy programs to those affected by Covid-19, including residents with lower incomes who receive basic food and cash assistance (Darma et al., 2020; Rulandari et al., 2022). This step is contemporary in nature, which does not guarantee poverty alleviation in the long term.

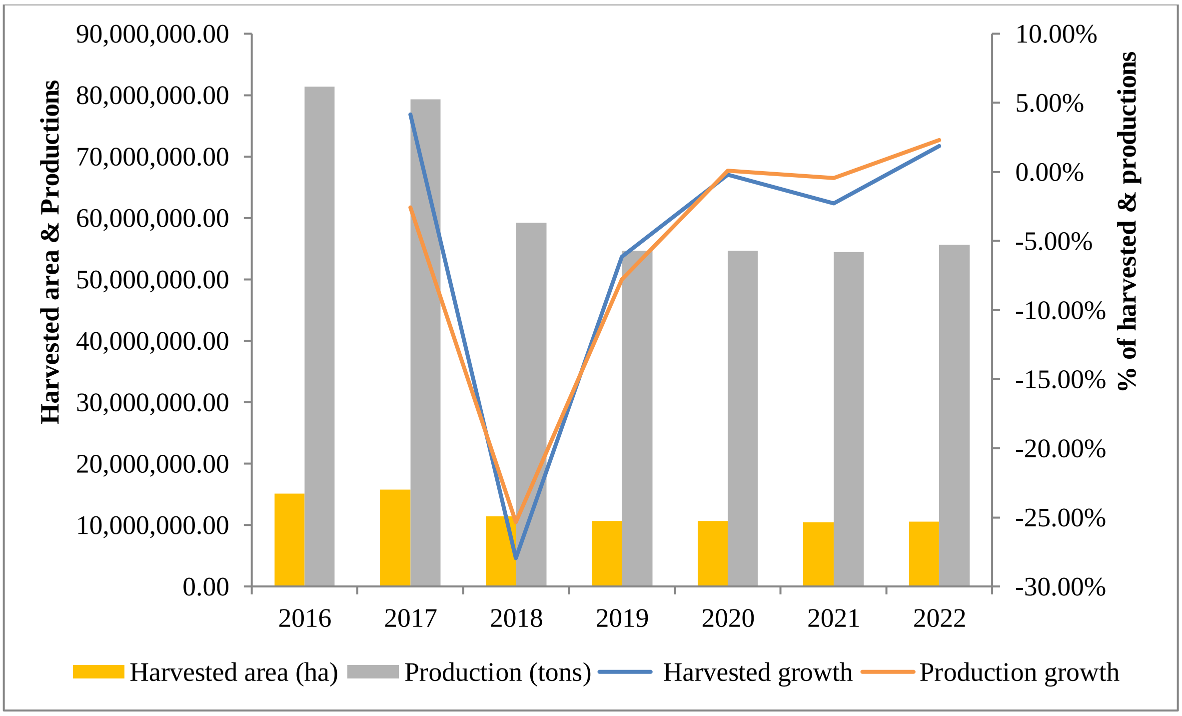

Figure 1. Harvested Area and Paddy Production
Source: BPS–Republic of Indonesia (2022a)

In general, the added value of agriculture based on rice plants is very dependent on the production cycle and harvested area (Bahri et al., 2023). Rice is an annual plant that is suitable for the tropical climate in Asia Pacific (Ansari et al., 2021). In practice, there is a depletion of harvested area and paddy production in Indonesia released by BPS–Republic of Indonesia. The harvested area and production of paddy (not yet converted to dry grain and rice) throughout the 7 periods experienced a drastic decline. During 2016–2022, the average harvested area was 12,098,127.44 hectares which

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resulted in paddy production reaching 62,745,827.71 tonnes. The aggregate growth in harvested area was reduced by 5.10% which automatically affected production quantity reaching -5.62%. Surprisingly, even though there was an increase in harvested area from 2016 to 2017 of 630,622.64 hectares (4.16%), production actually decreased by 2,083,390.84 tons or a growth of around -2.56%. What stands out is the harvested area and paddy production in 2021 until 2022 increased by 1.87% and 2.31%, but cumulatively the harvested area since 2017–2021 has experienced an aggressive decline. Likewise, paddy production for 2017–2019, then increased in 2020 to reach 54,649,202.24 tons (0.08%) and again decreased in 2020 to 2021 (-0.43%) and in 2022 slightly increased (see Figure 1). Jiuhardi et al. (2022) claim that this dynamic is triggered by the expansive development of rural areas, which tends to damage green areas, especially changing the function of agricultural land. The perspective of equal distribution of rural development by following urban-like modernization, is sometimes oriented towards natural resources, which ignores trans-local. The externality of land grabbing has reduced employment opportunities and at the same time increased unemployment, so that some residents leave the countryside to get proper welfare services.

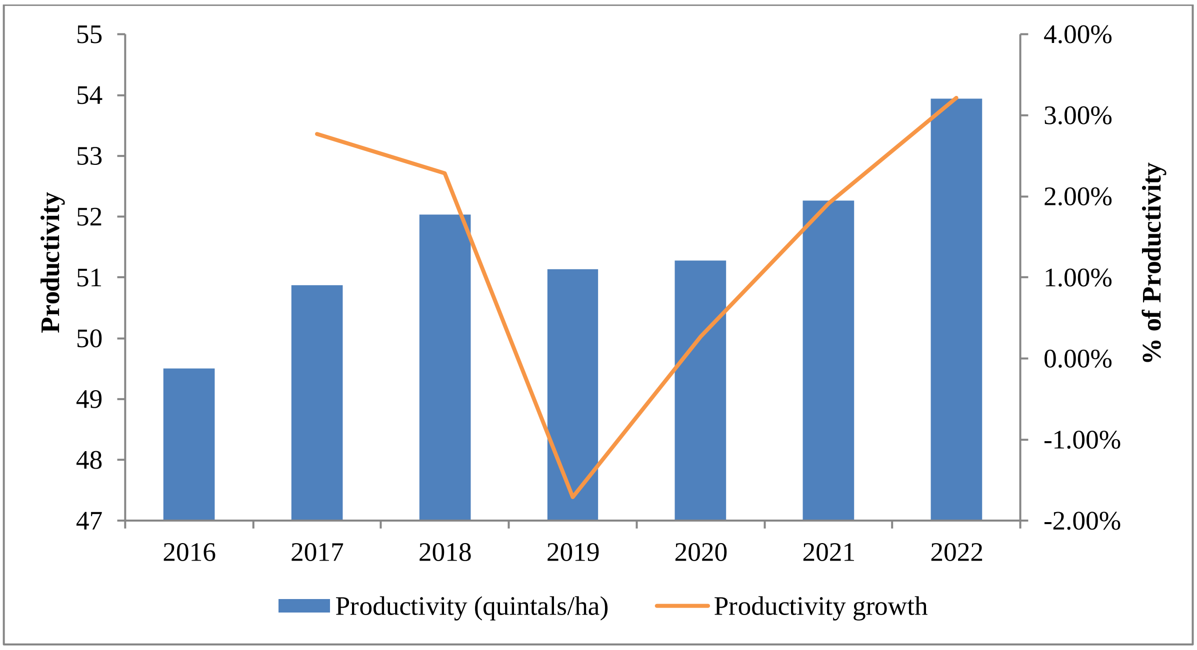

Figure 2. Paddy Productivity on a National Scale
Source: BPS–Republic of Indonesia (2022a)

As an agricultural country, Indonesia is known as a rice producing in the world (Panuju et al., 2013; Zainul et al., 2021). Moreover, Indonesia's paddy productivity is dominated by production centers in Java rather than other clusters outside the island. The reason is, there has succeeded in implementing the concept of efficient irrigation, integrated monitoring of agricultural management, or the insight and knowledge of farmers who have been an integral part for decades. Figure 2 describes paddy productivity on a national scale. In practice, the average paddy productivity in 2016–2022 reached 51.57 quintals per hectare, or a productivity growth of 1.46%. The highest paddy productivity in 2022 is 53.94 quintals per hectare (3.21%). What is striking is that there was a decrease of 1.71% for 2019 of 1.71% or productivity was recorded at 51.14 quintals per hectare. Apart from that, from

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2016 to 2018, paddy productivity grew by 2.52% and continued from 2020 to 2022 where the growth increased to 1.8%.

The position of agrofood in Indonesia has been regulated for a long time and has become an interconnected tradition that connects all situations, the stability of people, and the prosperity of achieving agricultural resources. The continued dependence of the Indonesian population on rice consumption has created a new polemic (Octastefani & Kusuma, 2015). In terms of food needs strategy, the rice supply chain is gradually experiencing food inequality: production–distribution–consumption, which urgently needs to be rearranged. Besides that, the conventional way of producing rice, processing it into rice products, and accommodating it to households is considered to need ideas framed by international standards. When Covid-19 changes social expectations, drives lifestyles, political crisis, and migration inequality, stakeholders involved in rice production include: farmers, manufacturing industry, logistics services, sellers, and consumers, need to stimulate improvements that can save resources without the hassle.

The dilemma is in strengthening institutions that dictate what types of food should be prioritized to stabilize food security. This precarious condition also triggers competition over the issue of prolonged conflict between importing countries and exporting countries (Erokhin & Gao, 2020; Koppenberg et al., 2020; Tang et al., 2022). While focusing on how agricultural production, retail, and consumption of agricultural-based commodities will return to their best, the urgency of agricultural cooperatives in selling and producing agricultural products. According to Tumenta et al. (2021), agricultural cooperatives also help farmers to strengthen production and prosper cooperative members. Because the benefits of agricultural cooperatives are so important, if their portion in the commodity chain decreases, it reduces the logistics supply to the population.

This complex interrelationship, makes the socio-economic burden increasingly increasing, where all parts are vulnerable to market failure. Too, the ban on part-time operations, working hours, or tightening and controlling as a health emergency agenda during Covid-19, has an impact on the suffering of farmers, weak markets, reduced finances, and difficulties in obtaining medical and educational services. The Covid-19 incident has become a valuable lesson for the food market, both producers, intermediaries and buyers. For this reason, the motivation for this paper is to provide an understanding regarding maneuvers in the rice supply chain before and during Covid-19. Paper organizing 5 points. First: the introduction initiates the phenomenon in the background (problem statement and research objectives, research elaboration, and developing hypotheses). Second: actualizing demarcation of methodology. Third: taking configuration of the findings. Fourth: evaluate the findings based on the discussion and conclusions summarizing the output results. Fifth: reconstructing recommendations, explaining limitations, and highlighting implications for future research directions. This scientific work is proposed to enrich academic thinking, add to the perspective of agricultural literature, distribute appropriate policy material in the rice supply chain, and function to optimize and cut the rice trade hierarchy which is considered inefficient.

The rice supply chain strategy in Indonesia is determined by the “supply-demand balance”. Relevant autonomy in the supply chain, collaborating between farmers and large millers, then supplied by traders and retailers, all the way to consumers (Guritno et al., 2021). This option certainly drains time, physical resources, and requires large logistical costs. Along with the increasing population, it is projected that rice consumption in Indonesia in 2045 will reach 31.7 million tonnes (Octania, 2021). Although food prices are fairly inclusive, the imbalance between rice demand and supply widens, leading to import licensing. Supply chain management (SCM) for the rice business

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has failed to control rice circulation in Indonesia (Putro et al., 2022). As an example from India, Sharma et al. (2013) offer a model in rice procurement via SCM which consolidates demand and reduces rice. The supply chain rests from the end to the downstream, where agents or companies take inventory.

Chronic food shortages in Indonesia until the 1960s were successfully overcome with "green revolution technology" which was supported by innovation in the availability of adequate irrigation, superior varieties, and the administration of high doses of synthetic fertilizers (Hidayat et al., 2020; Mariyono, 2015). Intensive rice (Oryza sativa) cultivation on a large scale often triggers endemic pests and diseases that require farmers to apply pesticides excessively. A group of people are concerned about the practice of the "green revolution" which narrows biodiversity and is not environmentally friendly. In comparison, the suggestion is to return to more sustainable agriculture through organic fertilizers. Naturally, paddy fields actually have the ability to self-renewal, if managed accurately (Delsouz Khaki et al., 2017; Shaohua et al., 2020).

Rice is a primary need in Indonesia to achieve carbohydrates and energy sources (Budijanto & Yuliana, 2015). If production decreases, it can affect food availability. In addition to market perceptions, the supply structure also influences rice production. Domestic food security still requires rice to support food adequacy. However, the pressure to increase rice production is often constrained by pest attacks, climate change, damage to irrigation networks, and conversion of agricultural land. The popular policy that is most often used by the government is diversifying food to control rice consumption. The Asian continent is home to the farmers who produce around 90% of the total global rice production. Rice cultivation is suitable in areas with warm climates, high rainfall, and low labor costs (Khairulbahri, 2021; Pheakdey et al., 2017). In fact, this staple food crop requires a large supply of water and labor. Areas that meet these criteria are generally located in Asia. The majority of farmers in Asia are those living in poverty (Fan & Rue, 2020).

Talking about topics related to rice, is always determined by the international trade market, protection and production of rice in Indonesia, and about how the government is advancing rice production towards food self-sufficiency. Given that the Indonesian population consumes large quantities of rice, this raises the risk when food prices will rise and burden poor households. More than half of the population's expenditure is spent on food ingredients. Indonesia has the ambition to achieve self-sufficiency in rice. In fact, Indonesia intends to become a rice exporter in the next few years. For that reason, the proof of seriousness is to stimulate creativity in the manufacturing industry. The bridging partnership between smallholders and industry aims to increase rice production, inspired by funding programs facilitated by more renewable technologies. Yanuarti et al. (2019) clarified that there has been a shift in the rice supply chain in Indonesia where the nature of its work is to flow information, products and finance in an asymmetrical relationship. Unfortunately, Indonesia's rice production and industrial base is only focused on 5 provinces: Lampung, East Java, West Java, Central Java, and South Sulawesi (Anggraeni, 2020; Erythrina et al., 2021; Maat, 2016; Pradana et al., 2017).

Processing grains into by-products such as rice involves several pathways, starting from paddy rearing to milling to produce edible final commodities (Bodie et al., 2019). Mariyono (2014) explains that technical efficiency can affect rice production performance. In the manufacturing industry, technical efficiency comes from: local culture, soil fertility, training programs and intensification. Without the presence of quality control, rice productivity cannot be guaranteed (Ekowati et al., 2020).

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After the dry unhusked rice is milled into rice and packaged, the next stage is delivery to agricultural cooperatives. Logistics deals with inventory, order processing, goods handling, transportation, facilities, and communication systems. In order for the results to be effective, the logistics process is carried out professionally. Movement, arrangement and storage of products, are recorded from the delivery package to the final customer, where everything is regulated in one supply chain. To maximize logistics, including the lowest costs, delivery of goods is carried out in the right units and on time. If it's urgent, then logistics activates package options that quickly arrive via air routes, such as using cargo planes or helicopters and special military aircraft for natural disasters. Normally, the distribution process between cities and villages on one island uses trailer trucks, commercial trucks, or double colt diesel depending on the volume transported. Yet, sea routes via ships are usually operated for the distribution of rice in larger loads and specifically between islands.

In Thailand, post-harvest, the key activities are warehousing, and transportation partners can become the main activities to develop logistics (Wiratchai et al., 2018). In the “supply chain intelligence” sketch for the rice industry, development in agriculture can cut logistics costs from upstream to downstream (Perdana et al., 2020). The quality of rice production emphasizes synergy in regional food transitions (Reuter & MacRae, 2019). Since BULOG has a role in maintaining and managing rice supplies, the use of warehousing for each regional division in Indonesia in distributing rice has become more controlled (Setiawan et al., 2020). Also, the frequency of transportation can save distribution costs. For example, in Vietnam, which has valuable assets in agricultural production, rice is a leading export commodity. In the scenario to boost rice output, the logistics system and transportation infrastructure are connected and equipped simultaneously, thus creating benefits for the system components. Then, rice logistics decision-making is influenced by freight transport management. In the rice industry in the Mekong Delta, reliance on freight power is always a concern to investigate (Pham, 2020; Thi & Thu, 2020). To prevent business restrictions and panic buying, such as crucial situations such as Covid-19, Purwadi et al. (2020) integrates logistics management and a more digitized supply chain in “retail direct orders”.

Initially, the motive for forming a cooperative economy for economic reasons was fundamental in the organization of family farming. The limited ability of the smallholder layer allows for a large wheel of profit in the agricultural sector. An agricultural organizational framework is also embedded to avoid high transaction costs for managing the farm. In developed countries, agricultural cooperatives play a role that cannot be ignored, but for developing countries, agricultural cooperatives are very limited in complementing the skills of farmers (Candemir et al., 2021; Tortia et al., 2013).

In fact, agricultural cooperatives in driving agricultural productivity in many countries appear to be more competent than Indonesia. In Central China, the consistency of cooperatives as drivers of supply chains and logistics, so that they are able to prosper cooperative members (Liu et al., 2020). Agricultural cooperatives in Brazil are quite prominent because some of the properties are owned by members who are associated with capital financing by banks (Neves et al., 2021). Agricultural cooperatives in Denmark, which have shone from time to time, have brought about impressive improvements and brought about strong negotiating forces among farmers, traders and cooperative members (Sandhu et al., 2022). In China, agricultural cooperative organizations help farmers achieve economic benefits and by implication pool their strengths to offer comprehensive cooperation (Zhang et al., 2021).

The Indonesian government's intervention to integrate agricultural cooperatives with the supply chain has rotated the price of rice from several between two localities (Makbul et al., 2020),

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but the atmosphere of agricultural cooperatives from Indonesia tends to be less familiar to many people due to their responsibilities which are almost similar to those of village unit cooperatives (KUD). The reason is, KUD are spread across all villages throughout Indonesia, while the establishment of agricultural cooperatives is based on zones that produce fisheries, plantations, forestry, animal husbandry, or food crops. Exclusively, KUD sometimes monopolize agricultural inputs, including the provision of fertilizers, seeds, and agricultural tools. This is what divides the empowerment of agricultural cooperatives in Indonesia. Holistically, Lopulisa et al. (2018) summarized the characteristics of agricultural cooperatives that are exposed to various risks. In fact, most agricultural cooperatives do not have agricultural insurance, low human resources, little farming capital, no land, and difficulty for individual farmers to access capital. At any given time, farmer contracts in agricultural cooperatives are only temporary. Therefore, the government must rethink to encourage their participation (Rokhani, et al., 2020).

In reality, the level of sales and purchasing power influences rice consumer behavior (Mgale et al., 2022; Ruspayandi et al., 2022; Suryadi et al., 2014; Wu et al., 2019). Wahyudi et al. (2019) examines the factors that influence the purchase of locally produced rice in Indonesia. In fact, income and product quality are positively correlated with the intention to buy rice. Increased consumer income indicates purchasing power of rice (Aprilia et al., 2016; Schmidt et al., 2021). Besides that, consumer trust in a particular brand is a big emotional tie, so that trust in producers is accompanied by increased sales.

In the rice value chain, consumer characteristics and industrial interests are expressed through heterogeneous relationships by differentiation (Custodio et al., 2019). The wave of urbanization in several cities has caused massive changes in the quality of rice. In Bangladesh, the mobility of rice grain has succeeded in changing the tastes of rich-income households (Mottaleb & Mishra, 2016). In general, the higher the household luxury, the greater the consumption of rice (Supriana & Pane, 2018). Michail Moatsos & Lazopoulos (2021) define a poverty line that is spread across middle and low income countries as measured by purchasing power parity. Low price levels and competitiveness put too much pressure on agricultural productivity (Gelb & Diofasi, 2016). Price volatility in the food market, including rice in Tanzania, is determined by the persistent purchasing power and income of the population (Mgale et al., 2022). From India, with little investment in extension, the government is promoting agricultural entrepreneurship that spreads quickly up the supply value chain (ICAR–National Rice Research Institute, 2022).

In the mode of health insurance, education costs, and government services, the government's treatment of rural and urban areas in large countries is inversely proportional to developing countries. What has caught the attention at the moment is the discrimination between fluctuating rice prices and the amount of stock and supply triggered by rice imports (Reza et al., 2014). Sales of rice to consumers in Southeast and South Asia were due to the rapid growth in per capita income and inclusiveness of purchases, while in Bangladesh the supply chain management mismatch (Bairagi et al., 2020; Rahman, 2019). Experience from Indonesia, overvalued rice has an impact on household income patterns (Takahashi & Barrett, 2014).

Figure 3 below illustrates the 2 mechanisms in the conceptual. The direct line reflects the interaction of the pre–Covid and post–Covid variables. On different corridors, the indirect line is represented by the compilation of the independent variables on the dependent variable, which is mediated by the intermediary variable.

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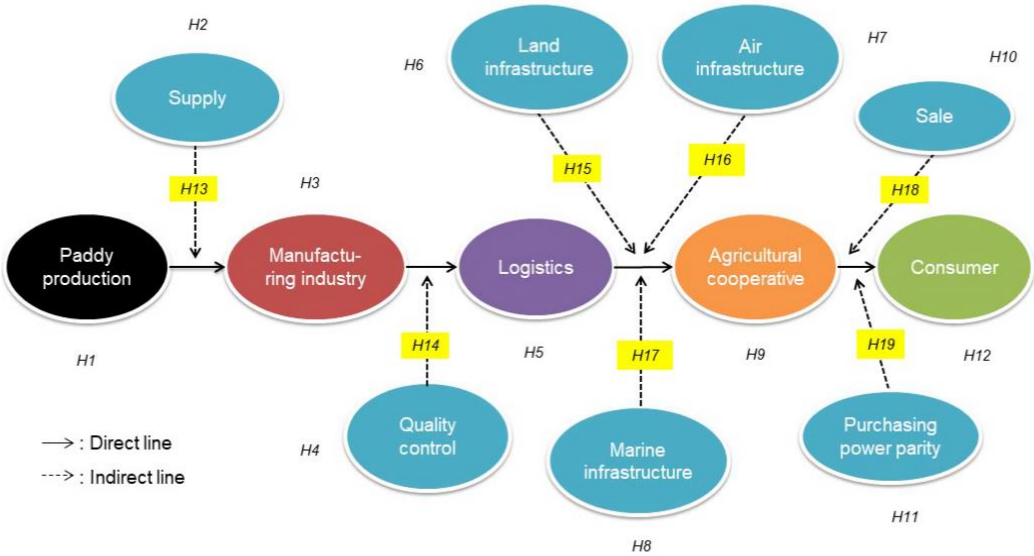

Figure 3. Basic Framework
Source: Authors (2022)

There are 12 variables in this study including: paddy production, supply, manufacturing industry, quality control, logistics, land infrastructure, air infrastructure, marine infrastructure, agricultural cooperatives, purchasing power parity, sales, and consumers. Referring to the theoretical arguments and premises, it is reasonable to propose the following alternative hypothesis:

1. Hypothesis 1: There is a significant difference in paddy production during pre-Covid and post-Covid.
2. Hypothesis 2: There is a significant difference in supply during pre-Covid and post-Covid.
3. Hypothesis 3: There are significant differences in the manufacturing industry during pre-Covid and post-Covid.
4. Hypothesis 4: There is a significant difference in quality control during pre-Covid and post-Covid.
5. Hypothesis 5: There are significant differences in logistics during pre-Covid and post-Covid.
6. Hypothesis 6: There are significant differences in land infrastructure during pre-Covid and post-Covid.
7. Hypothesis 7: There are significant differences in air infrastructure during pre-Covid and post-Covid.
8. Hypothesis 8: There are significant differences in marine infrastructure during pre-Covid and post-Covid.
9. Hypothesis 9: There are significant differences in agricultural cooperatives during pre-Covid and post-Covid.
10. Hypothesis 10: There is a significant difference in sales during pre-Covid and post-Covid.
11. Hypothesis 11: There is a significant difference in purchasing power parity during pre-Covid and post-Covid.
12. Hypothesis 12: There is a significant difference in consumers during pre-Covid and post-Covid.
13. Hypothesis 13: There is a significant difference in paddy production against manufacturing industry mediated by supply during pre-covid and post-covid.

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14. Hypothesis 14: There is a significant difference in the manufacturing industry against logistics mediated by the quality control during pre-covid and post-covid.
15. Hypothesis 15: There is a significant difference in logistics against agricultural cooperatives mediated by land infrastructure during pre-covid and post-covid.
16. Hypothesis 16: There are significant differences in logistics against agricultural cooperatives mediated by air infrastructure during pre-covid and post-covid.
17. Hypothesis 17: There are significant differences in logistics against agricultural cooperatives mediated by maritime infrastructure during pre-covid and post-covid.
18. Hypothesis 18: There is a significant difference in agricultural cooperatives against consumers mediated by sales during pre-covid and post-covid.
19. Hypothesis 19: There is a significant difference in agricultural cooperatives against consumers mediated by purchasing power parity during pre-covid and post-covid.

RESEARCH METHODS

Materials

Material sourced from annual publication data compiled from BPS–Republic of Indonesia. Data is collected collectively and selected based on the objectivity of the study. Secondary data covers the duration of 2017–2022. In data collection, the total sampling was not based on the level of productivity of the rice supply chain, but rather a population of panel data collected from cross-sections and time series to be divided evenly into 6 major regions in Indonesia.

Measurement of Variables and Sample

In principle, there are 3 variable dimensions for 2 test patterns consisting of: independent variable, dependent variable, and dependent variable. The first pattern identifies the probabilities of all independent variables including: paddy production, supply, manufacturing industry, quality control, logistics, land infrastructure, air infrastructure, marine infrastructure, agricultural cooperatives, PPP, sales, and consumers. Independent variables are articulated as variables that are independent or can stand alone without being influenced by other variables (Pham et al., 2020). The second pattern is to calculate the strength of the intermediary variable that mediates the relationship between the independent variable and the dependent variable. Supply, quality control, land infrastructure, air infrastructure, marine infrastructure, sales, and PPP are intermediary variables. In the context of mediating effects, the independent variables are designed to be paddy production, manufacturing industry, logistics, and agricultural cooperatives. On the one hand, the manufacturing industry, agricultural cooperatives, and consumers also serve as the dependent variable. Regarding benefits, intermediary variables are variables that bridging between the independent variable and the dependent variable, while the dependent variable is denoted as being responded to by the independent variable or the variable that is affected by the independent variable (Andrade, 2021; Jager et al., 2020).

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Table 1. Variable Operationalization

Key Variable	Definitions	Attribute
Paddy Production (PP)	Paddy production is harvested through a series of cultivation or growing seeds, maintenance, and regular fertilization which produces dry grain.	Million tons per year
Supply (Spl)	Stock of dry grain (after the selection and cleaning process) stored in the warehouse.	Million tons per year
Manufacturing Industry (MI)	A group of factories engaged in processing raw or semi-finished materials into finished products, including milling paddy into packaged rice.	Units per year
Quality Control (QC)	Factory routines to maintain and improve product quality through inspection according to criteria or targets. The essence is the separation between the net weight and the waste or dregs of rice.	Million tons per year
Logistic (Lgc)	Phases in the planning, storage, maintenance, supervision, delivery, and movement of rice products from the initial place to the destination.	Million tons per year
Land Infrastructure (LI)	The volume of rice transported from the logistics center to the delivery location using ground transportation.	Million tons per year
Air Infrastructure (AI)	The volume of rice transported from the logistics center to the shipping location using air transportation.	Million tons per year
Marine Infrastructure (MIr)	The volume of rice transported from the logistics center to the shipping location using sea transportation.	Million tons per year
Agricultural Cooperative (AC)	Active cooperatives that complement agricultural commodities related to certain rural products, such as rice.	Units per year
Sale (Se)	Business activities sell rice from agricultural cooperatives to consumers.	Million tons per year
Purchasing Power Parity (PPP)	Balance the purchasing power of household groups or economic preferences to equalize the price of identical batches of rice in different locations.	Rp/IDR per household in a year
Consumer (Csm)	Individuals, certain parties, or the last chain in the market flow that pays to get the quantity of rice with the aim of consuming needs.	Kg per capita in a year

Among these components, 8 variables: paddy production, supply, quality control, logistics, land infrastructure, air infrastructure, marine infrastructure, and sales have the same size. Uniquely, 2 variables: the manufacturing industry and agricultural cooperatives also have similar benchmarks. Only purchasing power parity and consumer benchmarks are different. Table 1 details the variable formats.

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Figure 4. Sample Map
Source: Authors (2022)

The total population is 432 which is obtained from multiplying the number of observations 2017–2022 times (6 periods) with a total variable (12 variables) and 6 regions. For 2 case studies: pre-Covid and post-Covid, the samples were divided into 2 frequencies of 216 units. Panel data for pre Covid is 2017–2019 and post Covid covers 2020–2022. Panel data is elaborated into 6 regions of Indonesia: Sumatra, Kalimantan, Java, Sulawesi, Maluku, and Papua. The sample distribution of each object is summarized in Figure 3. The sample format is not based on survey data (primary), but secondary data. In substance, the determination of the sample is 72 (n = 72) per island which is allocated from 432 population data.

Statistical Approach

Systematic analysis using parametric regression which is interpreted by 4 main parameters: descriptive statistics, multiple correlation, assumption of normality and regression procedure. Technically, descriptive statistics aim to verify the characteristics of a variable. Furthermore, correlations are represented by Pearson correlations, which predict two-way effects between variables. The independent-sample test becomes a proportion in the assumption of normality. Then, the steps in the regression procedure imply a different test and a Sobel test. In starting a descriptive statistical experiment, the formulation of the mean and standard deviation is written as follows:

$$\mu = \frac{\sum_{i=1}^{N} X_i}{N}$$

$$\overline{X} = \frac{\sum_{i=1}^{N} X_i}{N}$$

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Information:
μ : Mean score
$\overline{X}$: Sample average
N : Population
Xi : X value of i-th
i : Frequency

$$SD = \sqrt{\frac{\sum fx^2}{N}}$$

Information:
SD : Standard deviation
$\sum fx^2$: All deviations at the squared frequency of the sample
N : Population.

Pearson correlation describes the two–way effect of one variable on another. The correlation formula is arranged below:

$$r_{yx_i} = \frac{n \sum X_i Y - (\sum X_i)(\sum Y)}{\sqrt{n \sum X_i^2 - \sum X_i^2 \;\; n \sum Y^2 - \sum Y^2}}$$

Information:
r_{yx_i} : Correlation coefficient between Y and X
X : Independent variable
Y : Dependent variable
X_i : X value of i-th
Y_i : Y value of i-th
n : Lots of data.

Taking the hypothesis on Correlation is developed as follows:
1. H_a: There is a significant correlation.
2. H_o: No significant correlation.

Then, the standard in the assumption of normality is displayed with an independent-sample test containing Kolmogorov–Smirnov (K–S) and Shapiro–Wilk (S–W). The criteria in K–S and S–W are simulated as follows:

$$D = |F_s(x) - F_t(x)| \text{ max}$$

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Information:
D : Critical value
$F_s(x)$: Sample cumulative frequency distribution
$F_t(x)$: Theoretical cumulative frequency distribution
max : Maximum.

The conditions for taking the hypothesis on the absolute difference from the K–S test are detailed below:

1. H_a: Normal data distribution, while ρ-value $\geq$ 0.05.
2. H_o: Data distribution is not normal, while ρ-value < 0.05.

$$S - W = \frac{\left(\sum_{i=1}^{n} a_i \, x_{(i)}\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

α_i obtained from:

$$(\alpha_1, \alpha_1, \alpha_n) = \frac{m^T V^{-1}}{(m^T V^{-1} V^{-1} m)^{1/2}}$$

Information:
S-W : Shapiro and Wilk
α_i : Critical area
X_i : Item
$\bar{X}$: Sample average
$X_{(i)}$: Value on n – i
$m^T V$: Multivariate of PP, Spl, MI, QC, Lgc, LI, AI, MIr, AC, Se, PPP, and Csm.

The hypothesis transformation is defined as follows:

1. H_a: If ρ-value < 0.05, normal multivariate distribution data.
2. H_o: If ρ-value $\geq$ 0.05, multivariate distribution of data is not normal.

Paired-sample technique to test variable differences. Rationally. conditions are formulated as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} - 2r\left(\frac{S_1}{\sqrt{n_1}}\right)\left(\frac{S_2}{\sqrt{n_2}}\right)}}$$

Information:
$\bar{X}_1$: Sample average before treatment
$\bar{X}_2$: The average sample after treatment
S_1 : Standard deviation before treatment
S_2 : Standard deviation after treatment
r : Correlation between two samples

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2 : Number of samples after multiplication
n_1 : Number of samples before treatment
n_2 : Number of samples after treatment.

The following is the expectation of taking the hypothesis:

1. H_a: there is a significant difference between the initial variable and the final variable ($\rho < 0.05$).
2. H_o: there is no significant difference between the initial variable and the final variable ($\rho \geq 0.05$).

The Sobel test requires a large sample. If the sample size is small, the assumptions are less conservative (Abu-Bader & Jones, 2021; Koopman et al., 2015; Yay, 2017). This test concentrates on the indirect path in the relationship of the independent variable to the dependent variable, which is connected by an intermediary variable with the following econometric flow:

$$Z = \frac{ab}{\sqrt[2]{(b^2 SE_a) + (a^2 SE_b)}}$$

Information:
Z : Data deviation
a : Path of independent variables with intermediate variables
b : Mediating variable path with the dependent variable
SE_a : Standard error from the independent variable to the intermediate variable
SE_b : Standard error from the intermediate variable to the dependent variable.

In a quantitative scheme, variables can be independent when these variables cause changes or influence the emergence of the dependent variable. Then, the dependent variable that is measured in a scientific experiment because it depends on the independent variable. On statistical estimation, the intermediate variable is targeted to bridging the effect of the independent variable on the dependent variable. The intermediate variable functions hypothetically, where in fact it does not appear, but on premise it exists, and it affects the relationship between the independent and dependent variables. Finally, parametric regression modeling aims to test the indirect effect, where the equation function is specified as follows:

$$MI = \alpha_1 + [\beta_1 PP. \beta_2 Spl] + \varepsilon_1$$
$$Lgc = \alpha_2 + [\beta_3 MI. \beta_4 QC] + \varepsilon_2$$
$$AC = \alpha_3 + [\beta_5 Lgc. \beta_6 LI] + [\beta_5 Lgc. \beta_7 AI] + [\beta_5 Lgc. \beta_8 MIr] + \varepsilon_3$$
$$Csm = \alpha_4 + [\beta_9 AC. \beta_{10} Se] + [\beta_9 AC. \beta_{11} PPP] + \varepsilon_4$$

Information:
$\alpha_1,...\alpha_4$: Regression constant
$\beta_1,...\beta_{11}$: Coefficient
$\varepsilon_1,...\varepsilon_4$: Error

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Fundamentally, the decision hypothesis on intermediary effects is described below:

1. H_a: ρ-value < 0.05, where the intermediary variable mediates between the independent variable and the dependent variable.
2. H_o: ρ-value ≥ 0.05, where the intermediary variable does not mediate between the independent variable and the dependent variable.

The significance of one–way (1–tailed) and two–way (2–tailed) as instruments to reject or accept the hypothesis in each pillar. The 1–tailed probability aims to test one direction, and the 2 – tailed probability is the foundation for a two-way test.

RESULT AND DISCUSSION

Empirically, of the observed variables, 10 of them had normal distribution data and 2 of the status variables had a normal multivariate distribution (see Table 2). Based on the K–S test, data on supply, manufacturing industry, quality control, logistics, land infrastructure, air infrastructure, marine infrastructure, sales, PPP, and consumers are normally distributed (ρ = 0.200), while it is in contrast to paddy production (ρ = 0.020) and agricultural cooperatives (ρ = 0.014) whose data are not normally distributed. From the multivariate perspective, paddy production and agricultural cooperatives are normally distributed, where ρ = 0.002 and ρ = 0.019. This is inversely proportional to other variables whose data do not have an abnormal multivariate distribution. In a multivariate context, allowing handling in normality includes: supply (ρ = 0.346), manufacturing industry (ρ = 0.647), quality control (ρ = 0.529), logistics (ρ = 0.345), land infrastructure (ρ = 0.534), air infrastructure (ρ = 0.101), marine infrastructure (ρ = 0.260), sale (ρ = 0.345), PPP (ρ = 0.929), and consumer (ρ = 0.178). Responding to the existing normality assumption, data on paddy production and agricultural cooperative in the rice supply chain concept can be ignored or combined to avoid abnormalities in the distribution of data. Even though the contribution of the two to the normality criteria: 35.1% and 36.1% and multivariate: 62.9% and 74.9%, the data needs to be corrected or re-matched, add or narrow the sample, and remove outliers that have extreme scores.

Table 2. Data Normality

Variables	Kolmogorov–Smirnov		Shapiro–Wilk	
	Statistic	Sig.	Statistic	Sig.
Paddy Production	0.351	0.020	0.629	0.002
Supply	0.210	0.200*	0.895	0.346
Manufacturing Industry	0.239	0.200*	0.938	0.647
Quality Control	0.202	0.200*	0.923	0.529
Logistic	0.211	0.200*	0.895	0.345
Land Infrastructure	0.196	0.200*	0.924	0.534
Air Infrastructure	0.266	0.200*	0.827	0.101
Marine Infrastructure	0.234	0.200*	0.878	0.260
Agricultural Cooperative	0.361	0.014	0.749	0.019
Sale	0.211	0.200*	0.895	0.345
Purchasing Power Parity	0.194	0.200*	0.976	0.929
Consumer	0.243	0.200*	0.857	0.178

Information: *Lower Bound of the True Significance

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Table 3 exposes the descriptive statistical values and correlations. Of the variables, the SD score and the mean varied. For SD, supply is the biggest: 17,697,211.6, while consumers are the lowest: 6.29. In the mean score, paddy production is the most dominant compared to other variables reaching 59,639,723.8 and consumer as the smallest is 76.61. At a 95% confidence interval, there is a significant two-way correlation between paddy production to supply (ρ = 0.026) and consumers (ρ = 0.017), supply to consumers (ρ = 0.034), manufacturing industry to quality control (ρ = 0.040), logistics (ρ = 0.048), land infrastructure (ρ = 0.033), sale (ρ = 0.048), and PPP (ρ = 0.032), quality control to agricultural cooperatives (ρ = 0.023), logistics to agricultural cooperatives (ρ = 0.011), land infrastructure to agricultural cooperatives (ρ = 0.039), and agricultural cooperatives to sales (ρ = 0.011). In a statistical interpretation with a probability of 5% (ρ <0.05), the two models are in fact the most striking before and after Covid-19. The first is logistics to agricultural cooperatives and the second is agricultural cooperatives to sale, where the inharmonious logistics led to a decline in agricultural cooperatives by 91.2%. At the same time, a series of problems at the agricultural cooperative also reduced sales by 91.2%.

Separately, referring to the 99% confidence interval, there is also a significant two-way correlation between quality control of logistics (ρ = 0.000), land infrastructure (ρ = 0.000), marine infrastructure (ρ = 0.001), and sales (ρ = 0.000), then the logistics for land infrastructure, marine infrastructure, and sales, the whole of which is ρ = 0.000. Then, land infrastructure to marine infrastructure (ρ = 0.002) and sale (ρ = 0.000), marine infrastructure to agricultural cooperatives (ρ = 0.009) and sale (ρ = 0.000), and agricultural cooperatives to consumers (ρ = 0.005). Based on the application of 1% probability (ρ < 0.01), a spectacular record is created. It is calculated that the quality of logistics increases 100% of sales. The central position is controlled by logistics, which are related to driving sales completely.

Table 3. Correlation Matrix and Descriptive Statistics

Var.	SD	Mean	PP	Spl	MI	QC	Lgc	LI	AI	MIr	AC	Se	PPP	Csm
PP	9,797,933.62	59,639,723.8	1	0.864*	0.612	-0.645	-0.673	-0.623	-0.297	-0.654	0.741	-0.673	-0.803	0.891*
				(0.026)	(0.196)	(0.167)	(0.143)	(0.186)	(0.568)	(0.159)	(0.092)	(0.143)	(0.054)	(0.017)
Spl	17,697,211.6	48,859,217	0.864*	1	0.346	-0.376	-0.424	-0.329	-0.535	-0.423	0.648	-0.424	-0.421	0.846*
			(0.026)		(0.502)	(0.463)	(0.402)	(0.525)	(0.275)	(0.404)	(0.164)	(0.402)	(0.406)	(0.034)
MI	12,529.14	167,503.5	0.612	0.346	1	-0.832*	-0.815*	-0.848*	-0.043	-0.704	0.617	-0.815*	-0.850*	0.557
			(0.196)	(0.502)		(0.040)	(0.048)	(0.033)	(0.935)	(0.119)	(0.192)	(0.048)	(0.032)	(0.251)
QC	832,171.64	1,821,017.67	-0.645	-0.376	-0.832*	1	0.996**	0.997**	-0.030	0.977**	-0.873*	0.996**	0.784	-0.745
			(0.167)	(0.463)	(0.040)		(0.000)	(0.000)	(0.954)	(0.001)	(0.023)	(0.000)	(0.065)	(0.090)
Lgc	476,252.18	1,386,661.17	-0.673	-0.424	-0.815*	0.996**	1	0.986**	0.055	0.983**	-0.912*	1.000**	0.781	-0.794
			(0.143)	(0.402)	(0.048)	(0.000)		(0.000)	(0.917)	(0.000)	(0.011)	(0.000)	(0.067)	(0.059)
LI	329,909.7	701,600	-0.623	-0.329	-0.848*	0.997**	0.986**	1	-0.090	0.964**	-0.834*	0.986**	0.801	-0.700
			(0.186)	(0.525)	(0.033)	(0.000)	(0.000)		(0.866)	(0.002)	(0.039)	(0.000)	(0.056)	(0.121)
AI	56,261.53	229,799.83	-0.297	-0.535	-0.043	-0.030	0.055	-0.090	1	-0.003	-0.370	0.055	0.017	-0.480
			(0.568)	(0.275)	(0.935)	(0.954)	(0.917)	(0.866)		(0.996)	(0.470)	0.917	(0.975)	(0.336)
MIr	150,317.45	455,261.33	-0.654	-0.423	-0.704	0.977**	0.983**	0.964**	-0.003	1	0.921**	0.983**	0.710	-0.799
			(0.159)	(0.404)	(0.119)	(0.001)	(0.000)	(0.002)	(0.996)		(0.009)	(0.000)	(0.114)	(0.057)
AC	13,315.72	134,617.5	0.741	0.648	0.617	-0.873*	-0.912*	-0.834*	-0.370	0.921**	1	-0.912*	-0.626	0.944**
			(0.092)	(0.164)	(0.192)	(0.023)	(0.011)	(0.039)	(0.470)	(0.009)		(0.011)	(0.184)	(0.005)
Se	476,252.18	1,186,661.16	-0.673	-0.424	-0.815*	0.996**	1.000**	0.986**	0.055	0.983**	-0.912*	1	0.781	-0.794
			(0.143)	(0.402)	(0.048)	(0.000)	(0.000)	(0.000)	(0.917)	(0.000)	(0.011)		(0.067)	(0.059)
PPP	277,455.34	11,111,667	-0.803	-0.421	-0.850*	0.784	0.781	0.801	0.017	0.710	-0.626	0.781	1	-0.651
			(0.054)	(0.406)	(0.032)	(0.065)	(0.067)	(0.056)	(0.975)	(0.114)	(0.184)	(0.067)		(0.161)
Csm	6.29	76.61	0.891*	0.846*	0.557	-0.745	-0.794	-0.700	-0.480	-0.799	0.944**	-0.794	-0.651	1
			(0.017)	(0.034)	(0.251)	(0.090)	(0.059)	(0.121)	(0.336)	(0.057)	(0.005)	(0.059)	(0.161)	

Noted: *ρ is 5% and **ρ is 1%.
Abbreviations: Paddy Production (PP); Supply (Spl); Manufacturing Industry (MI); Quality Control (QC); Logistic (Lgc); Land Infrastructure (LI); Air Infrastructure (AI); Marine Infrastructure (MIr); Agricultural Cooperative (AC); Sale (Se); Purchasing Power Parity (PPP); Consumer (Csm).

Table 4 addressing the partial probabilities of each variable and mediating relationships. From the Paired-sample test, it was specifically modified to have a significant effect on the different

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treatments given to each variable or there was no significant effect on the different treatments given to the variables. Meanwhile, the Sobel test is aimed at identifying the multiplier effect of the intermediary variable. Statistical output detects that during pre-Covid and post-Covid, there was significant causality to the manufacturing industry, quality control, logistics, land infrastructure and sales. Another overview explains that pre-Covid or post-Covid did not have a significant impact on paddy production, supply, air infrastructure, marine infrastructure, agricultural cooperatives, consumers and PPP. On pre-Covid and post-Covid, it has been proven that paddy production has a significant relationship to the supply-driven manufacturing industry. Aggressively, logistics also has a significant relationship with agricultural cooperatives, driven by land infrastructure and marine infrastructure. Uniquely, the manufacturing industry actually slows down logistics mediated by quality control, air infrastructure which does not play a significant role in the link between logistics and agricultural cooperatives, and agricultural cooperatives which also do not have a significant effect on consumers through sales and PPP.

Table 4. Result of Paired–Sample and Sobel Test

From	Intermediary	To	t	Sig. (2-tailed)	Remarks
PP	–	–	1.215	0.348	H_1: rejected
Spl	–	–	1.286	0.327	H_2: rejected
MI	–	–	4.375	0.048*	H_3: accepted
QC	–	–	-6.024	0.026*	H_4: accepted
Lgc	–	–	-4.586	0.044*	H_5: accepted
LI	–	–	-7.059	0.019*	H_6: accepted
AI	–	–	-0.535	0.646	H_7: rejected
Mir	–	–	-2.722	0.113	H_8: rejected
AC	–	–	1.831	0.209	H_9: rejected
Se	–	–	-4.586	0.044*	H_{10}: accepted
PPP	–	–	-2.814	0.106	H_{11}: rejected
Csm	–	–	1.419	0.292	H_{12}: rejected
PP	Spl	MI	1.898	0.047*	H_{13}: accepted
MI	QC	Lgc	-0.045	0.963	H_{14}: rejected
Lgc	LI	AC	-16.864	0.000**	H_{15}: accepted
Lgc	AI	AC	-0.898	0.369	H_{16}: rejected
Lgc	Mir	AC	-28.735	0.000**	H_{17}: accepted
AC	Se	Csm	0.124	0.044*	H_{18}: accepted
AC	PPP	Csm	0.077	0.938	H_{19}: rejected

Noted: *Probability is 5% and **Probability is 1%.
Abbreviations: Paddy Production (PP); Supply (Spl); Manufacturing Industry (MI); Quality Control (QC); Logistic (Lgc); Land Infrastructure (LI); Air Infrastructure (AI); Marine Infrastructure (MIr); Agricultural Cooperative (AC); Sale (Se); Purchasing Power Parity (PPP); Consumer (Csm).

Logically, of the 19 hypotheses proposed, 9 mission hypotheses were accepted and the remaining 10 were rejected. During pre-Covid and post-Covid, there was significant progress towards the manufacturing industry ($\rho = 0.048$), quality control ($\rho = 0.026$), logistics ($\rho = 0.044$), land infrastructure ($\rho = 0.019$), and sales ($\rho = 0.044$). Another analogy highlights that the more paddy production increases, the more significant influence the manufacturing industry is supported by supply ($\rho = 0.047$). Table 4 also concludes that land infrastructure ($\rho = 0.000$) and marine infrastructure (ρ = 0.000) play an important role in the significant influence of logistics to agricultural cooperatives. Specifically, although the accepted hypotheses are detected to be significant, the negative partial coefficients are reflected by quality control (t = -6.024), sales and logistics (t = -4.586), and land infrastructure (t = -7.059). Likewise with the increase in logistics when shipments were concentrated via land (t = -16.864) and marine (t = -28.735), agricultural cooperatives actually decreased. A positive trend occurred in the manufacturing industry (t = 4.375) and collectively in supply to the manufacturing industry (t = 1.898), as well as agricultural cooperatives towards consumers through sales (t = 0.124).

This paper is dedicated to the rice supply chain system in Indonesia in the 2017–2019 period. The results of the analysis found that the manufacturing industry, quality control, logistics, land infrastructure, and sales had a significant impact pre–Covid and post–Covid. At the same moment, paddy production has a significant effect on the manufacturing industry through supply and logistics, which has a significant effect on agricultural cooperatives through land and marine infrastructure. Thus, the uncertainty in Indonesia's rice supply chain is rooted in quality control, logistics, land infrastructure, and sales. Other findings on the mediating effect mentioned that land and air infrastructure is not the best route to stimulate rice logistics access to agricultural cooperatives. Only PPP can support agricultural cooperative to consumer. Although not significant, the partial effects that are not affected by any situation are paddy production, supply, agricultural cooperatives, and consumers. In essence, natural supply chains are rooted in the four, where these variables represent the scope of producers/farmers–distributors–consumers.

In developing markets, such as Indonesia, the extensive network of rice supply chains makes distribution complicated (Erlina & Elbaar, 2021). Generally, in rice-consuming countries that have large landmass and few islands, the flexibility of rice delivery relies on land infrastructure (Cramb, 2020). A case study for Indonesia, which has thousands of islands, requires thousands of sea and land transportation to distribute rice to its destination, where moving the product is quite time-consuming. Too to high food prices in the outermost regions, the smooth distribution is disrupted by a lack of infrastructure which also has an impact on rising energy tariffs (Allo et al., 2018; Faharuddin et al., 2022; Farandy, 2020; Ismaya & Anugrah, 2018). When the disaster is not resolved for a long time, air transportation costs are increasingly expensive. The air infrastructure is devoted to operating to send rice to isolated islands, which sacrifices large logistics costs. Despite this remote island not having extensive agricultural land, land grabbing there often occurs as a result of the exploitation of natural gas, coal and oil. Air infrastructure was also instructed to transport food and supplies to disaster mitigation areas.

Farmers' cooperatives can serve one or more functions including but not limited to providing loans to farmers, providing information relating to agricultural production, selling inputs necessary for agricultural production, bargaining on behalf of its members, providing transportation services, and marketing agricultural products. Supply will not run when demand is hampered, as well as demand that is relevant to supply levels. The task of agricultural cooperatives has actually been to acquire the various needs of farmers. Unfortunately, the weakness lies in the education and discipline of cooperative managers in supplying agricultural household needs, including rice. Agricultural cooperatives in urban areas are more preventive in developing institutions and classifying trade systems than agricultural cooperatives from rural areas (e.g. Francesconi et al., 2021; Harimaya & Kagitani, 2022; Li, 2013; Paos, 2018).

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In Indonesia, agricultural cooperatives are less popular than developed nations which are regulated not only as sellers, but also play a dual role as distributors (Halilintar, 2018; Soetriono et al., 2019; Widjojo, 2018). In this case, the supplier is the rice farmer or supplier providing dry grain and those in charge of processing the grain into rice as well as distributors and collectors are held by factories engaged in the manufacturing industry. In other words, this is a quite risky anomaly, where speculators, especially the private sector can control, hoard rice stocks and resell them at high prices, making it difficult for the government to get actual rice-related data. This regulatory uncertainty is also often exploited by small groups aiming at profit and avoiding taxes when people with lower incomes lose subsidized rice.

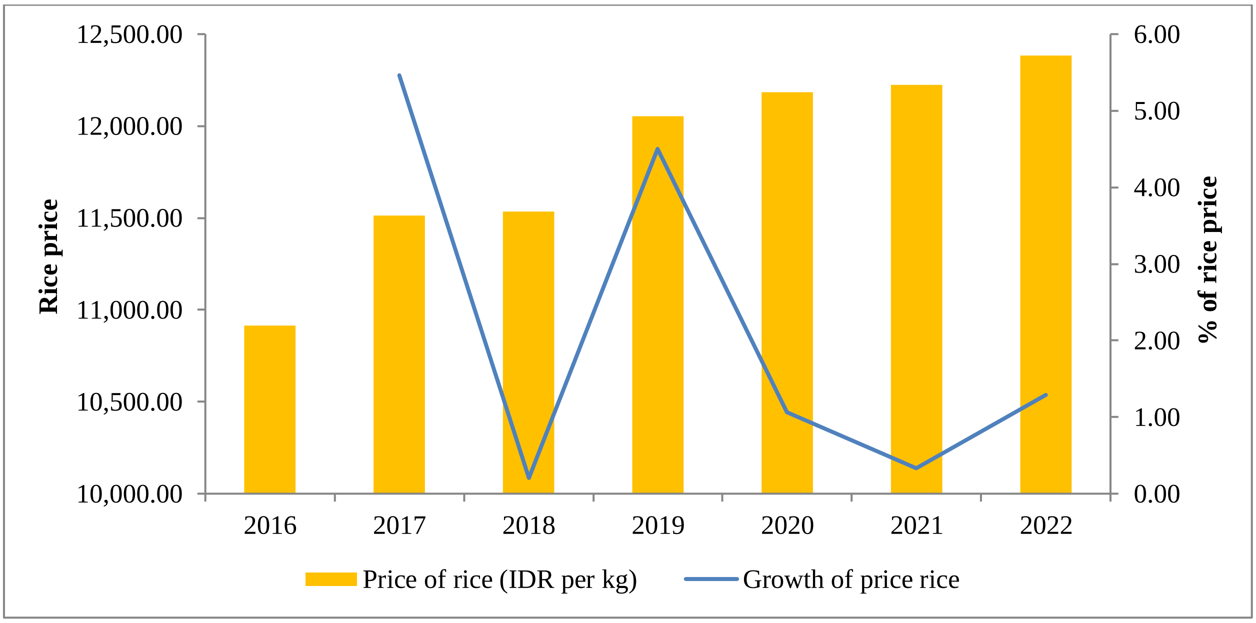

Figure 5. Average Price of Rice at the Wholesale Level
Source: BPS–Republic of Indonesia (2022b)

Indonesia's readiness to reduce rice inflation creates a dilemmatic debate, whether the regulation will increase rice prices to benefit farmers and traders, or save the welfare of the population via a cheap rice policy. Each period, especially from 2016 to 2021, the average rice price at the trader scale is Rp 11,829.28/kg. The annual rice price which grew 2.14% only represents the national price and does not represent remote areas. In detail, the highest annual rice price growth was in 2016, where the growth was 5.46% or an increase of Rp 596.21 from IDR 10,915.13/kg in 2016 to Rp 11,511.34/kg in 2017. A decrease of 5.26% in 2018, the average price of rice reached Rp 11,534.93/kg. After that, it grew again by 4.5% and increased by Rp 519.55 in 2019. When social restrictions triggered social restrictions, forced the annual rice price to fall again by 3.44% in 2020 and 0.73% in 2021. In these two critical periods, the average price of rice is Rp 12,183.03/kg and Rp 12,223.98/kg or annual growth is 1.07% and 0.34%. Even though there is an easing of Covid-19 towards a "new normal" in 2022, now the annual price of rice has again increased by Rp 158.12 from 2021 to 2022 or a growth of 1.29% (see Figure 5).

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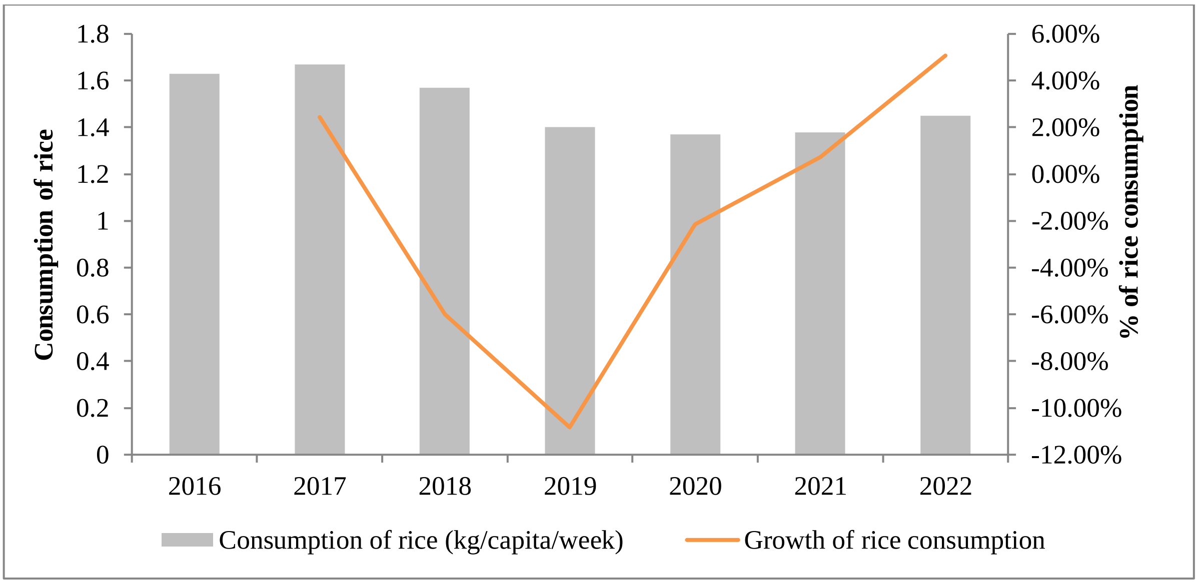

Figure 6. Average Rice Consumption
Source: BPS–Republic of Indonesia (2022b)

The average Indonesian population consumes 1.5 kg of rice per week in 2016–2022. During these 7 periods, the growth in rice consumption per week was -1.78%. There is such a wide gap between people who have a rich and middle income profile and poor people, so that access to rice consumption is relatively owned by those who are prosperous. Disparities in the level of rice consumption are also triggered by production locations, industries, manufacturing industry clusters, and logistics zones between large and small islands in Indonesia. Also, a survey by the Ministry of Agriculture proved that there is still manipulation of data related to rice production and stock, so that at the stage of delivery and distribution of rice to agricultural cooperatives it is not under the capacity requirements. Figure 6 above also illustrates that for each resident, the fantastic average consumption will actually reach 1.45 kg per week in 2022, where the growth is 5.07%. In fact, before Covid-19, in 2017 to be precise, the average consumption was around 1.67 kg per week or grew by 2.45%. From 2018 to 2019, the average weekly consumption of rice was the lowest, reaching -10.83% or 1.4 kg per week. When the large-scale lock-down was implemented in 2020, the average population's rice consumption was 1.37 kg per week and the growth was up to -2.14%. In 2021, the instinct of most household groups is to prioritize rice, the average consumption growth will be 0.73% or an increase of 0.01 kg per week from the previous period.

Regardless of the residue from the Covid-19 attack which is a complaint in the rice supply chain system, the argumentative debate of which technical authority should be responsible for this problem is being debated. From a certain point of view, driving rice supply in the manufacturing industry sector is the most accurate pillar before getting to the delivery stage. However, the fragility of farmer participation in paddy production is also the initial foundation for damage to the supply chain system. To counteract weaknesses in the rice supply chain when the spread of the pandemic is getting higher, things like tightening rice cultivation routines are also not an alternative. Furthermore, reducing the volume of rice shipments to agricultural cooperatives is an optional option. The replacement that can also be postponed temporarily is the wasted consumption of rice which can be anticipated using a variety of other foods such as wheat, cassava, corn and sago whose nutritional content is equivalent or even more than rice. Unknowingly, the outlook for the rice supply chain crisis

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could be adapted by empowering local plants from each region that is considered to have profitable economic diversification.

CONCLUSION AND SUGGESTION

Overall, this scientific paper calculates the multidimensional disruption in the rice supply chain from across the major islands in Indonesia. During a normal situation and after a pandemic, paddy production, supply, air and marine infrastructure, agricultural cooperatives, purchasing power parity and consumers did not experience significant disruption. Likewise, the manufacturing industry towards logistics played by quality control, logistics towards agricultural cooperatives via air infrastructure, and agricultural cooperatives towards consumers which are mediated by purchasing power parity seem unaffected. Even though it appears to be progressing, this paper detects that without a mediation channel, the manufacturing industry, quality control, logistics, land infrastructure, and sales are directly affected. Other estimates indicate a decline in development and growth from purchasing power parity to the manufacturing industry through supply, logistics to agricultural cooperatives through land and marine infrastructure, and agricultural cooperatives which distribute rice to consumers in a sale mechanism.

This finding is a pioneer and solution to weak paddy production, supply, quality control, land, air and marine infrastructure, as well as agricultural cooperatives, sales, consumer and PPP in the rice supply chain, providing space for continuous improvement. Weaknesses of the findings also consider the follow-up article agenda and embrace all elements that understand various polemics. In the rice supply chain hierarchy, we criticize the government for being less sensitive in empowering farmers. Intervention must be in the context of "agrarian reform" carried out through integrated counseling, synergizing agricultural business permits, and facilitating the making of agricultural land certification free of charge.

Recognizing the role of mediating variables such as a manufacturing industry that functions optimally, but quality control to maintain local rice wisdom is still under the national label. Referring to its identity, it requires a revolutionary quality control under a qualified authority. The results also provide knowledge about air infrastructure which has a mediating effect that is not significant from logistical relations to agricultural cooperatives, where in the process of moving rice via airplane, strict protocols must be observed. Then, sales and PPP that connect agricultural cooperatives with consumers are insignificant, tend to be caused by the Covid-19 factor which had limited the routines of workers, students, and the activities of all parties in the economic sector, thereby reducing welfare in the short term.

Academic implications teach us that spatial aspects such as Indonesia which has obstacles in interisland transportation can disrupt the security of rice, rice processing, logistics, bankruptcy of agricultural cooperatives, and the prosperity of the population. Based on these five threats to the supply chain system, future expectations can provide theoretical knowledge. In addition, practical policies that are decided must be careful, related to strategies to combat the Covid-19 variant, improve irrigation networks, transparency of rice stock data, revitalize the tasks of agricultural cooperatives, and guarantee food subsidy programs.

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